Topological Insulators: The Physics of Spin Helicity in Quantum Transport

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This book is the result of dynamic developments that have occurred in condensed matter physics after the recent discovery of a new class of electronic materials: topological insulators. A topological insulator is a material that behaves as a band insulator in its interior, while acting as a metallic conductor at its surface. The surface current carriers in these systems have Dirac-like nature and are protected by an intrinsic topological order, which is of great interest for both fundamental research and emerging technologies, especially in the fields of electronics, spintronics, and quantum information.

The realization of the application potential of topological insulators requires a comprehensive and deep understanding of transport processes in these novel materials. This book explores the origin of the protected Dirac-like states in topological insulators and gives an insight into some of their representative transport properties. These include the quantum spin–Hall effect, nonlocal edge transport, backscattering of helical edge and surface states, weak antilocalization, unconventional triplet p-wave superconductivity, topological bound states, and emergent Majorana fermions in Josephson junctions as well as superconducting Klein tunneling.

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